MULTIMEDIA UNIVERSITY®

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2015/2016

PPH0125 – MECHANICS

(Foundation in Engineering - All Sections / Groups)

10 OCTOBER 2015
9.00 A.M – 10.00 A.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **SIX** printed pages, excluding the cover page and appendixes, with **SIX** questions.

2. Answer **ANY FIVE** questions. The distribution of the marks for each question is given.

3. Write all your answers in the Answer Booklet provided.

4. All necessary workings **MUST** be shown.

ANSWER ALL QUESTIONS

QUESTION 1 (10 Marks)

a) What is the difference between a speed and a velocity?

(2 marks)

b) A train covered 500 km between 1.00 p.m. and 6.00 p.m. Determine the average velocity of the train?

(3 marks)

c) Three objects are connected on the platform as shown in **Figure Q1(c)**. The platform is rough and has a coefficient of kinetic friction of 0.30 whereby the pulleys are frictionless. Determine the acceleration of each object and their directions.

(5 marks)

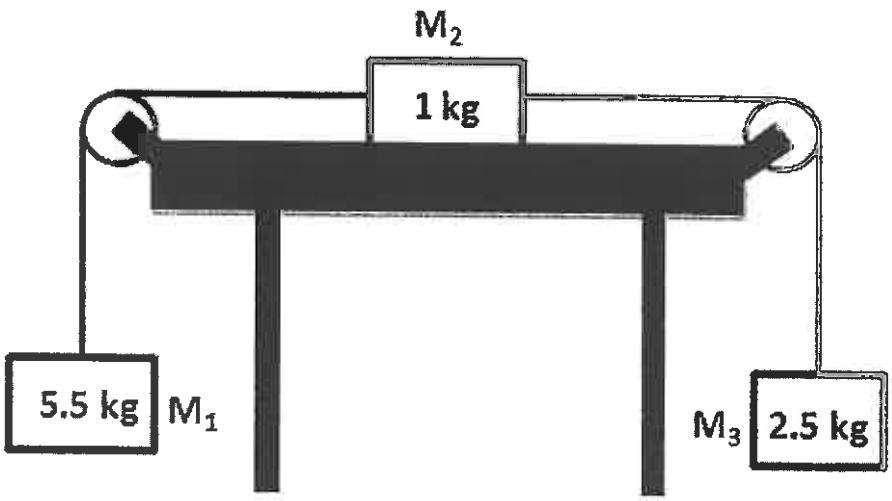

Figure Q1(c)

Continued...

QUESTION 2 (10 Marks)

a) What do you understand by Static Equilibrium and Translational Equilibrium?

(2 marks)

b) A group of students construct a structure representing some of the major food groups as shown in **Figure Q2(a)**. Determine the masses m_1, m_2 *and* m_3 that are required for a perfectly balanced condition.

(5 marks)

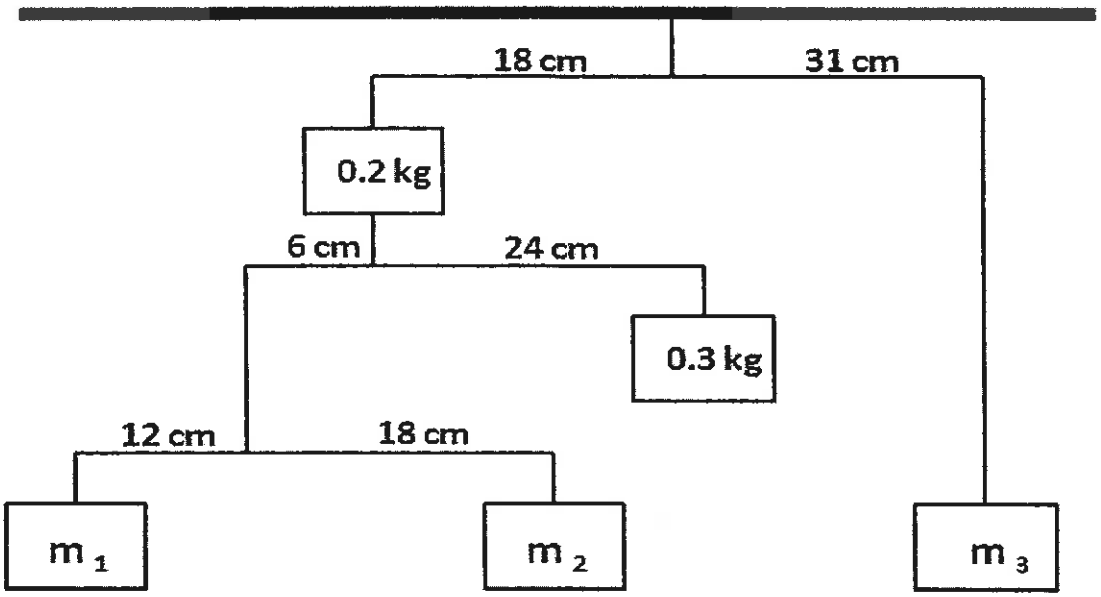

Figure Q2(a)

c) A 15 kg block is dragged over a rough, horizontal surface by a 70 N force acting 20^{o} above the horizontal as shown in **Figure Q2(b).** The block is displaced 5.0 m and the coefficient of kinetic friction is 0.30. Find the kinetic energy of the block?

(3 marks)

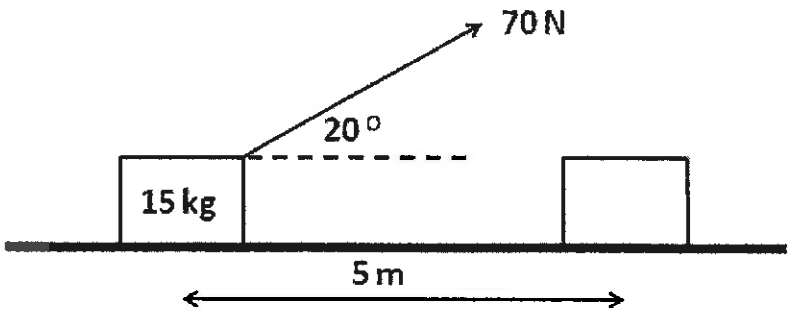

Figure Q2(b)

Continued...

QUESTION 3 (10 Marks)

a) State the Law of Conservation of Angular Momentum.

(1 mark)

b) An object has a mass of 500 g, moves at a speed of 6 m/s along the circumference of a circle of radius, 3 m as shown in **Figure Q3(b)**. Determine the:

(i) centripetal force acting on the object in rotation

(2 marks)

(ii) centripetal acceleration

(1 mark)

(iii)period of rotation

(2 marks)

(iv)distance covered in every rotation

(2 marks)

(v) angular momentum of the object

(2 marks)

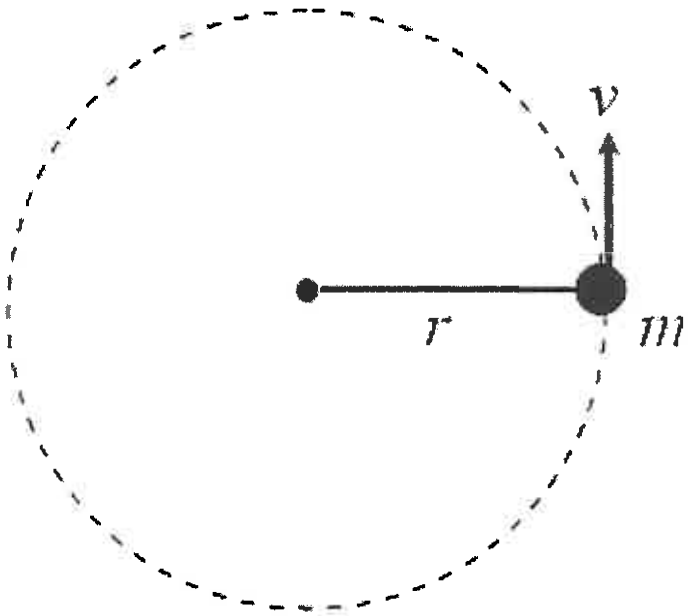

Figure Q3(b)

Continued...

QUESTION 4 (10 Marks)

a) State Newton's Law of Universal Gravitation.

(1 mark)

b) State the three Kepler's Laws.

(3 marks)

c) A new satellite of the Earth has a mass of 500 kg and is placed into orbit at an altitude of 3000 km as shown in **Figure Q4(b)**.

(i) Determine the radius of the orbit of the satellite in meters.

(1 mark)

(ii) What is the magnitude of the gravitational force exerted by the Earth on the satellite?

(1 mark)

(iii) What is the gravitational potential energy of the satellite-Earth system?

(1 mark)

(iv) Determine the value of gravitational acceleration, g_s at the satellite.

(1 mark)

(v) Calculate the speed of the satellite orbiting the earth.

(1 mark)

(vi) Determine the period of the satellite.

(1 mark)

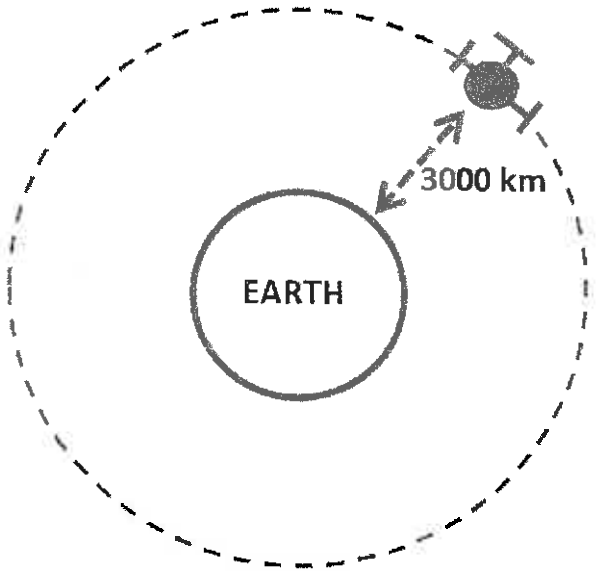

Figure Q4(b)

Continued...

QUESTION 5 (10 Marks)

a) A cubical box 20.0 cm on a side is completely immersed in a fluid as shown in **Figure Q5(a)**. At the top of the box the pressure is 105.0 kPa and at the bottom the pressure is 106.8 kPa. What is the density of the fluid?

(4 marks)

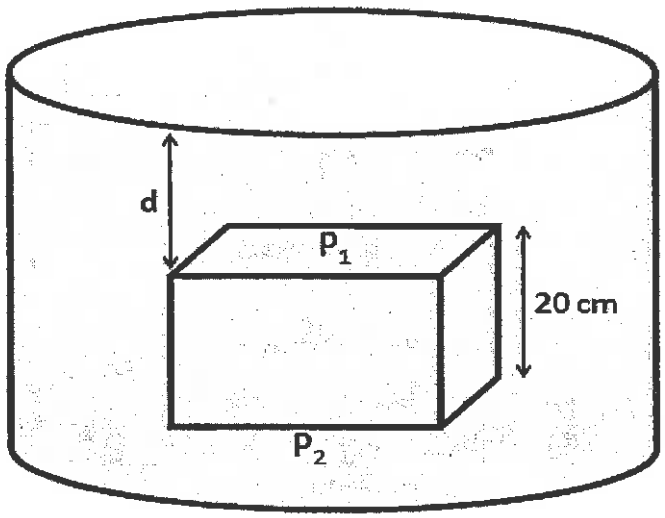

Figure Q5(a)

b) State briefly the Archimedes's Principle.

(1 mark)

c) An object weighing 720.0 N in air is lowered into a tank of water as shown in **Figure Q5(c)**, submerging entire object. If the apparent weight while submerged is 34.3 N, determine the volume and the density of the object.

(5 marks)

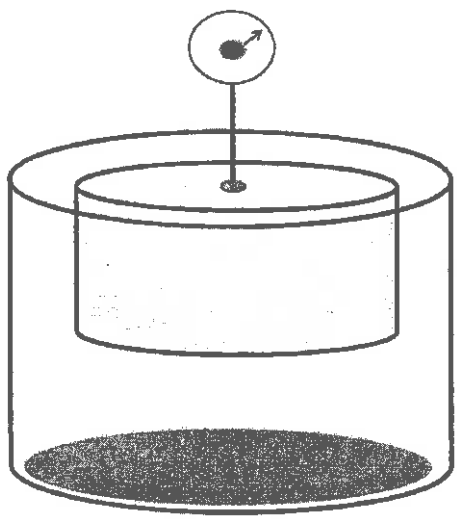

Figure Q5(c)

Continued...

QUESTION 6 (10 Marks)

An object oscillates with simple harmonic motion along the x-axis. Its displacement from the origin varies with time according to the equation:

$$x(t) = 6.00\text{m}\ \sin[2\pi t]$$

a) What do you understand by Simple Harmonic Motion?

(1 mark)

b) Determine the amplitude, the angular frequency, the frequency, and the period of the motion.

(2 marks)

c) Calculate the velocity and acceleration of the object at any time, t.

(1 mark)

d) Determine the position, velocity and acceleration of the object at t=1.0s.

(1.5 marks)

e) Determine the maximum speed and acceleration of the object.

(1 mark)

f) Find the displacement of the body between t=0 and t=1.0s.

(1.5 marks)

g) What is the phase of the motion at t=2.0s?

(0.5 mark)

h) Sketch a graph of displacement versus time for the above motion if the motion is lightly damped.

(1.5 marks)

End of Paper

APPENDIX I

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 / kg^2
Universal gas constant,	R	=	8.314 J/ mol.K
Hydrogen ground state,	E_0	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_c	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity of earth,	g	=	9.80 m/s^2
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_0	=	1.0×10^{-12} W/m^2
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_0}$	=	9.0×10^9 N.m^2 /C^2
Permittivity of free space,	ε_0	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ T.m/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Wein's displacement constant		=	0.2898×10^{-2} m.K
Speed of Sound in Air		=	343 m/s
Refractive index of air/vacuum	n	=	1.0
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

APPENDIX II

LIST OF FORMULAS IN MECHANICS

$y = kx^n$

$\frac{dy}{dx} = knx^{n-1}$

$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$ $\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$ $\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

$v = v_o + gt$ $y - y_o = v_o t + \frac{1}{2}gt^2$ $v^2 = v_o^2 + 2g(y - y_o)$ $y - y_o = \left(\frac{v_o + v}{2}\right)t$

$a_c = \frac{v^2}{r}$ $F_g = G\frac{m_1 m_2}{r^2}$ $U_g = -G\frac{m_1 m_2}{r}$ $T^2 = K_s r^3$

$\tau = r \times F$ $\sum \tau = \tau_{net} = I\alpha$ $I = \sum mr^2$ $v = r\omega$

$L = r \times p = I\omega$ $K = \frac{1}{2}I\omega^2$

$T_s = 2\pi\sqrt{\frac{m}{k}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$

$x = A\cos\omega t$ $x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $v = \omega A\cos\omega t$

$a = -\omega^2 A\cos\omega t$ $a = -\omega^2 A\sin\omega t$

$v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$

$v = v_o + at$ $x - x_o = v_o t + \frac{1}{2}at^2$ $v^2 = v_o^2 + 2a(x - x_o)$

$x - x_o = \left(\frac{v_o + v}{2}\right)t$

$W = mg$ $\sum F = F_{net} = ma$ $f_s \le \mu_S F_N$ $f_k = \mu_K F_N$

$p = mv$ $\sum F = \frac{\Delta p}{\Delta t}$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $PE_s = \frac{1}{2}kx^2$ $F_s = -kx$ $PE_G = mgy$